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Letter to the Editor

Delayed cerebral ischemia after subarachnoid hemorrhage: Comparing and integrating classification systems

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Sir,

Subarachnoid hemorrhage (SAH) is a significant healthcare problem. It is estimated that 30000 Americans suffer from aneurysmal SAH each year. Delayed cerebral ischemia (DCI) is one of the major causes of morbidity and mortality after SAH, and occurs in 20–40% of patients.[4,5,8] To better predict and diagnose DCI after SAH, multiple grading scales have been published, of which the Fisher score is the most well-known.[3] More recently, this score has been modified to predict symptomatic vasospasm after SAH more accurately.[4] Many other prediction models have been developed and published, and some of them use different parameters to calculate various outcomes that are associated with DCI and vasospasm.[1,2,7] Here, we present the SAH DCI app, which was developed to facilitate comparison between the various grading scales and to aid physicians in the use of prediction models. It incorporates automated calculation of a maximum of seven SAH grading scales, namely, the WFNS SAH grade, the Hunt and Hess grade, the original and modified Fisher grade, the early prediction scale by De Rooij *et al.*, the BEHAVIOR score, and the VASOGRADE score.[1-4,6,7,9] The WFNS SAH grade and the Hunt and Hess grade are general outcome predictors, and the other classification systems are specific predictors for DCI.

We developed and evaluated a mobile medical app for iOS (Apple Inc, Mountain View, CA) using class 1 CE-marked technology for risk minimization. The app, called SAH DCI, has been evaluated by all authors independently, where the results of the mobile clinical decision support system were compared with manually calculated scores, which were based on the original classification systems. The app provided identical results compared to manual calculation of the relevant classification systems.

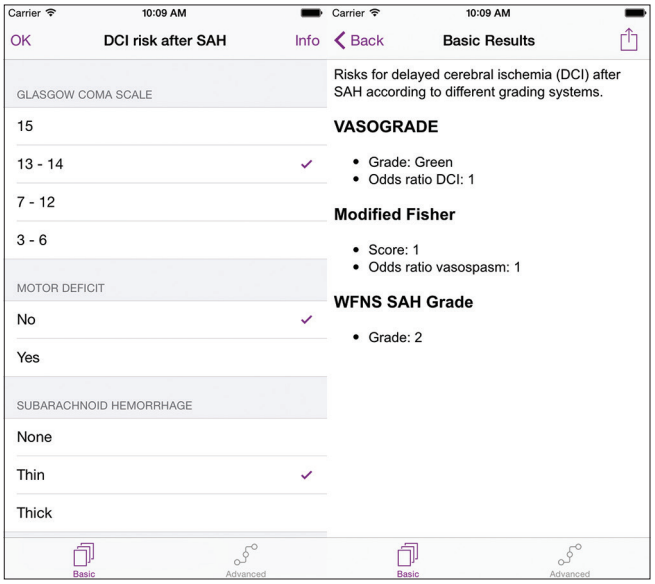

Figure 1: SAH DCI basic module (3 classification systems)

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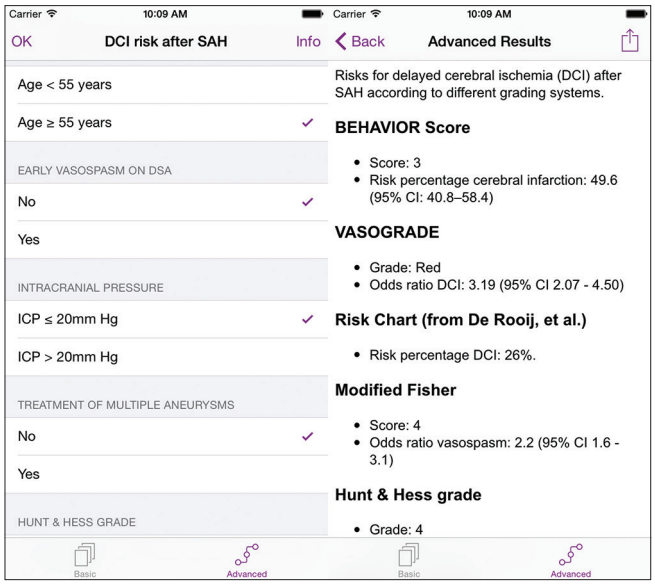

Figure 2: SAH DCI advanced module (7 classification systems)

The app consists of two screens, a basic module and an advanced module. The basic module asks 4 questions to calculate 3 grading scales (WFNS SAH Grade,[9] Modified Fisher,[4] and VASOGRADE[1]) An example is illustrated in Figure 1. The advanced module asks 10 questions to calculate 7 grading scales (the WFNS SAH grade,[9] the Hunt and Hess grade,[6] original and modified Fisher grade,[3,4] early prediction scale by De Rooij *et al*.,[2] the BEHAVIOR score,[7] and the VASOGRADE score[1]). An example is illustrated in Figure 2. Both the modules offer the ability to export all user input and provide recommendation by email for later reference [Figure 3]. Email is sent unencrypted, which is clearly displayed. No patient identification details are necessary to use the app.

In conclusion, the SAH DCI app offers clinicians a user-friendly and accurate tool for mobile clinical decision support on DCI after SAH. It combines multiple classification systems for risk calculation that may help to guide treatment, as well as ease and quicken the clinical implication of different SAH scores. Further research and comparative effectiveness studies focusing on different classification systems are needed to extract the main parameters that predict DCI after SAH.

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Nil.

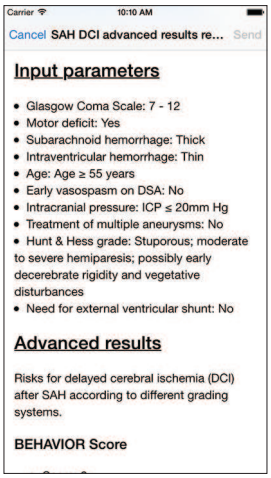

Figure 3: Export results by email dialog

Conflicts of interest
The first author is the developer of the app. Other authors report no conflict of interest.

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